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MERION BLUEGRASS SEED PRODUCTION

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The photograph above was taken on February 18, 1956, five months after the field was seeded at the rate of 1.3 pounds per acre, ¼-inch deep. Field was irrigated up seven days after planting.

Merion bluegrass is a cool-weather plant that does well at 1,000- to 4,000-foot elevations. Acreages in California are increasing as markets open for seed.

This circular provides information for the grower who may wish to add this new cash crop to his acreage. The material covered includes seed production and harvesting.

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WHAT IS MERION BLUEGRASS?

Merion turf is resistant to drought and to major leaf-spot diseases.

Merion Bluegrass was first observed at the Merion Golf Club in Ardmore, Pennsylvania, as a natural selection of Kentucky bluegrass. In 1936, the American Golf Association included vegetative material of this selection, as B-27, in turf plots for testing. After 12 years, B-27 was selected as superior to all other bluegrasses being tested.

Merion, or B-27, under proper care, forms a tight, dense turf under close mowing, which is highly resistant to *Helminthosporium* leaf spot, common in the eastern United States. It is also relatively drought-resistant, and able to withstand invasion by crabgrass.

Merion differs from common bluegrass in several ways. It is slower growing and is 6 to 12 inches shorter than Kentucky bluegrass at maturity. Under uniform growing conditions, this difference in height is apparent even before the heads appear. The seed heads are generally smaller than those of Kentucky bluegrass, and emerge from the boot at least a week or more later. Merion seed is slightly shorter, broader, and not so pointed as Kentucky bluegrass. This causes the spikelets and heads to appear short, blunt, and more chubby.

A cool-weather plant—short days, low temperatures best for seed production.

Bluegrass is essentially a cool-season grower. Vegetative and seed production phases of growth are greatly affected by day length and temperature.

The greater part of the development of new foliage takes place during the fall and spring when day lengths are rather short. Prolonged cool weather during those periods favors maximum vegetative development. During the winter period, an undetermined number of days with less than 12 hours of daylight, coupled with temperatures below 40° F, are essential to condition the plants for seed production. After this winter induction period, the warm spring days of increasing length cause the flowers to develop.

Merion bluegrass potted in the field in September, 1954, and removed to greenhouse (long days, warm temperatures) at dates shown on pots. Two plants with seed, at right, had the advantage of short days and low temperatures of winter.

At Davis, jointing usually starts near the first of March. Seed heads start to emerge from the boot about April 1, and are flowering within 30 days. About 15 days after flowering, the seed is in the soft dough stage and will be maturing within another 10 to 15 days. At higher elevations than Davis, the entire process will be delayed a month or more.

1,000- to 4,000-foot elevations are best in California.

Major producing areas of Merion bluegrass seed are located in Oregon, Washington, and Idaho. Crop acreage restrictions and the increasing search for new cash crops have interested some California growers in Merion, and some is now being produced in this state.

Cropland areas of California where Merion can be grown most successfully will be those where fall and spring temperatures are suitable for maximum plant growth and development. Mountain valleys of intermediate elevations (1,000 to 4,000 feet), or areas having long periods of cool spring and fall weather, are most suitable. Spring frosts at flowering time will be a hazard. The Central Valley area of California or locations where the necessary cool

spring and fall growing periods are rather short are not conducive to maximum seed yields. Within such areas, early unseasonal hot weather coinciding with flowering and seed development will drastically lower yields.

Yields from 200 to 600 pounds per acre. Merion acreages increasing as markets open for seed.

Under ideal soil fertility, moisture, and climatic conditions, seed yields of 600 pounds or more per acre are not uncommon. Under poor growing conditions, or where periods of warm fall and spring temperatures occur, yields cannot be expected to be much over 200 pounds.

Acreages seeded to Merion have steadily increased in the past few years. The national acreage in 1957 was 12,260, producing 2,342,000 pounds of seed. As retail prices for Merion continue to decline, it may be expected to share a considerable portion of the large Kentucky bluegrass market.

HOW IS MERION SEED PRODUCED?

Best soils—loamy, friable, easy to work. Flat-plant on firm seedbed.

Although there are no experimental data on soils best suited to Merion production, observation and experience suggest that soils near neutral or slightly acid are best. Excellent growth has been observed on peat soils of an old lake bed, on well-drained sandy loam, and on extremely rocky areas.

In general, soils should be loamy, friable, and easily worked, to provide a suitable environment for satisfactory rhizome and root development. Soils that are in poor physical condition or that do not sub across well should be avoided. The most productive stands will be grown on the better soils.

Merion bluegrass should be flat planted on a well-prepared, weed-free seedbed. The seedbed should provide a firm layer of soil upon which the seed can be drilled and covered. Irrigation furrows should be shallow to allow water to penetrate across the rows. It is important to keep the soil moist in the crown area. Planting bluegrass on raised beds often results in inadequate soil moisture in the crown area of the plants, thus limiting normal rhizome development and restricting the total area in production. In addition, raised-bed planting can complicate harvesting.

Row plantings are better than broadcast, and August–September is the best planting period.

Row plantings of grass seed crops maintain higher seed yields over a longer period of time. Broadcast stands make roguing and weed control difficult, if not impossible, and prevent uniform water distribution. Such stands soon become sod or root bound, resulting in low yields.

Above: plants in foreground are on high beds. Because moisture did not penetrate crowns, their centers are dead, rhizomes are stunted, and plants are poor. Below: rows in background of same field. These plants received adequate moisture around crowns. Growth is vigorous and rapid.

The choice of row spacing depends somewhat on farming equipment available. Twenty, 28-, 30-, and 36-inch row spacings are being used, with 28- and 30-inch most common.

The date of seeding can be very important in relation to the stand that may be expected. When the soil is warm, bluegrass will germinate in a relatively short time. The longer the germinating seedlings remain below the soil surface, the greater the mortality that may be expected (table 1). When the land has been properly prepared, and good control of irrigation water is possible, excellent stands can be obtained quickly from mid-August to mid-September by irrigating the stand up. The seedbed can be carefully prepared in the spring and kept clean-fallowed until seeding time.

Seeding trials indicate that stands established at least by the first of September, and grown under good moisture and soil fertility conditions, can produce a reasonable seed crop the following June or July. Such an early seeding may produce enough seed the first year to compensate for the year's operation costs.

In many areas the common practice is to seed in the late fall or early spring and depend upon winter and spring rains to establish the stand. Seedings made during this period are slow to germinate, and suffer a high mortality rate and strong competition from fast-growing weeds. Seedings made as late as November generally produce little or no seed the following spring. Established plants from late fall or spring seedings must be carried through the next winter before a seed crop can be expected.

Table 1. Effect of Seeding Date, Average Air and Soil Temperatures on Emergence of Merion Bluegrass

Date seeded at depth of ¼ inch	Number days before seedlings started to emerge	Viable* seed having produced seedlings 15 days from start of emergence	Temperature from date of seeding to emergence		
			Average air temp.†	Moist soil temperature at seed depth	
				High	Low
		per cent	°F	°F	°F
Aug. 18, 1954	7	94.6	72.2	101	52
Sept. 30, 1954	9	89.8	69.1	85	43
Oct. 29, 1954	15	55.1	55.9	79	39
Jan. 17, 1955	26	30.1	45.0	58	30

* Based on laboratory test of 83 per cent germination.
† Derived by using daily maximum and minimum temperatures.

Merion bluegrass seed is very small and lightweight (about 2.2 million per pound); thus seeding rates are low. Field plantings at 1 to 2 pounds per acre have produced excellent stands. Studies show that the emergence of bluegrass is best when seed is planted about ¼ inch deep. Shallow seeding necessitates frequent irrigations to keep the soil surface moist until the stand has emerged. Maintaining a uniform distribution and depth when drilling is essential for obtaining a uniform stand. Under unfavorable germinating conditions or poor seedbed preparation, higher seeding rates may be desirable.

Seed treatment to reduce emergence losses from soil fungi is highly desirable if damping-off is a problem in the area. Follow carefully the manufacturer's recommendations for use of the fungicide.

The root system is shallow, and frequent irrigations are required.

Frequent irrigations are required, because the effective root system for seed production is relatively shallow (about 1½ feet). The water-holding capacity of soils varies widely, and it is therefore not possible to give specific recommendations for frequency of irrigations. The yearly seed crop is largely dependent upon the amount of new growth developed during the fall and subjected to the short days and low temperatures of winter. For this reason, Merion should go into the winter period with the maximum amount of new growth. Starting about the latter part of August or first of September, soil about the crowns and roots should be well supplied with moisture, and the stand should be kept in a vigorous growing condition. This will insure maximum growth, and build up a stored reserve in the plants to stimulate vigorous spring growth.

The most critical period of water use is during and after flowering. Plant stress because of lack of adequate moisture at this time can cause blasted flowers or shriveled seed. Under stress, bluegrass leaves fold along the mid-rib, look wilted, and take on a dull, darker green color. Irrigations should be frequent enough to prevent signs of stress and should be continued as close to harvesting as possible. After harvest, the frequency of irrigations can be reduced but the crop must be irrigated often enough to keep the stand alive. In some areas, after harvest, it is possible to discontinue irrigations for the summer.

Seed production responds to high nitrogen rates.

Applications of nitrogen produce marked increases in vegetative growth and seed yields. It should be remembered, however, that response to fertilizers varies greatly, depending upon soils and previous cropping history.

A developing first-crop-year stand will profitably utilize 80 to 125 pounds of nitrogen per acre. Older stands will

Close-up of field shown on page 2. Plants have made good growth. Seeding was done with a Planet Jr. seed drill, using a No. 9 hole on the seed plate.

These plants are on a high spot in the field. Growth is very sparse, and plant crowns are dying from lack of moisture at the row centers.

A section of a two-year-old stand in which plantings were on beds that were too high. Irrigation water did not penetrate crown areas, and rhizome development was poor. Plants formed separate clumps; spaces in between were taken over by weeds.

need 150 to 200 pounds. Approximately two-thirds of the total should be applied in the fall in at least two increments. The remaining third should be applied as early in the spring as possible, preferably just prior to the resumption of growth. High nitrogen applications in the spring can stimulate vegetative growth to the detriment of seed production. Phosphorus (50 to 60 pounds per acre) and possibly potash (20 to 40 pounds per acre) applied in the fall with the nitrogen are often beneficial to seed production. Where known deficiencies occur, higher rates are in order.

Weed control is especially important the first year.

Do not compromise with weeds. They are much faster in germination and seedling growth than is bluegrass. Many weed seeds and seeds of other grasses are difficult, costly, and sometimes impossible to remove from the harvested seed crop. It is less costly to remove the weeds from the field than from the seed after harvest.

Mechanical weed control is more dependable.

The most difficult period of weed control is during the first crop year, including stand establishment. For this reason, only clean land should be used. The weedy grasses are more difficult to control than are broadleaf weeds. Weed control should start as soon as the grass rows can be defined. Growers should place more dependence for weed control upon mechanical methods than upon chemical ones. Rotary tillers and rotary beaters can sometimes be effective in controlling a smothering crop of fast-germinating, broadleaf weeds that have developed in a seedling stand during a long, rainy winter. Shields should

Another section of the same two-year-old stand shown on opposite page. Here, shallow beds allowed irrigation water to penetrate across into crown areas. Extensive rhizome development resulted in thick growth that crowded out weeds.

be used on mechanical equipment to keep dirt from being thrown on the grass rows.

When Merion is in the three-leaf stage of growth, averaging about ½ inch or more in height, no adverse effects have been noted from the application of 2,4-D, 2,4,5-T, and MCP at rates of ¾ to 1 pound acid equivalent per acre. Only slight effects from these applications were noted where water had remained in slight depressions after an irrigation.

Very small weeds have been controlled by a pre-emergence spray of a 40 per cent emulsion of weed oil and water at 100 gallons per acre. Small seedling broadleaf weeds were effectively controlled with a postemergence spray of 5 quarts Sinox-W in 100 gallons of water per acre, during early March. No wetting agent was used, and little active material remained on the grass leaves. However, some spot burning of the grass leaves did occur. Contact, nonselective weed killers can be used between rows if adequate shields are used to protect the grass stand.

Phenyl mercuric weed killers should never be used on Merion.

Because Merion has been reported extremely sensitive to phenyl mercuric weed killers, this type of herbicide should never be used on Merion bluegrass. (See Stoutemeyer, V. T., "Merion Bluegrass in California," *Southern California Turf Culture,* Vol. 3, No. 2, 1953.)

Some growers may be tempted to mow bluegrass stands in the fall or spring as a weed-control measure. Close mowing tests at Davis in late October showed seed yields reduced by two thirds. Mowing in the spring will remove the developing seed heads.

Roguing of off-types is necessary to maintain the Merion type.

Most of the seed crop is produced without fertilization having taken place. This results in a seed germ with a genetic makeup identical with that of the mother plant. These seeds will produce plants true to the Merion type. Some seed, however, is produced by normal fertilization. Plants from such seed will not be Merion, but are considered off-types, resembling every variation of Kentucky bluegrass. With each succeeding generation removed from breeder's seed, the percentage of off-types can be expected to increase.

Seed producers should obtain registered or foundation seed, or seed from fields known to be relatively free of off-type plants. Regardless of the planting stock used, off-type plants will be found in seed fields, and should be rogued out. Chopping with a hoe will keep these plants from producing seed, but enough plant material will remain to insure continued growth. Off-types should be completely removed.

Chemical control of off-types, Kentucky bluegrass, and other undesirable grasses is possible by spot spraying with Dalapon at ¾ pound of active material in 3 gallons of water.

During the winter and spring, new culms emerging as terminal growth of rhizomes cause the rows to spread, narrowing the inter-row spacings. This is desirable because

Left: tall heads of Kentucky bluegrass in a stand of Merion. Lack of heads in center was result of poor water penetration. Right: tall, early maturing heads are off-types and/or Kentucky bluegrass among Merion.

the more area actually occupied by plant material, the greater the potential seed yield may be. Late-emerging culms will not develop any appreciable amount of seed during that season, and generally are too short to harvest. The new growth developed, however, will be producing the following crop year. Inter-row spacing need be only wide enough to allow for movement of equipment in the field and proper irrigation coverage. The actual maximum width of these developing beds must be governed by the success with which each irrigation will penetrate the soil surface at their centers.

Second- or third-year production declines, and no completely satisfactory system of renovation is known.

After the second or third crop year, the amount of new growth capable of abundant seed production declines in the center of the beds. This condition is accentuated if it is difficult to keep adequate moisture in that area of the beds. Although many techniques have been tried by growers and investigators, no completely satisfactory method of stand renovation has been developed.

Any treatment which will open up or remove the accumulation of dead plant material in the row centers will be beneficial if done well in advance of beginning of vigorous fall vegetative growth. Adequate soil moisture and available nitrogen must be supplied if any treatment is to be successful in reviving this center area. The following treatments have given varying degrees of success: (1) removing plugs from the rows with airifiers; (2) spreading the straw and burning the stubble after harvest; (3) close clipping after harvest. This can be done with a conventional mower or rotary beater.

Red spider mites and aphids are major pests of Merion. Systox controls both.

Red spider mites and aphids have been major pests encountered in the production of Merion bluegrass seed in California.

Red spider builds up heavy populations on the regrowth after harvest and continues to be active until cold weather in late fall. Severe infestations cause the bluegrass to appear as if continually suffering from drought. The situation is made more difficult because the folding leaves protect the insects from contact or fumigative insecticides.

At Davis, **aphids** build up heavy populations about the first of April, depending on weather conditions. If not promptly controlled, aphids will greatly reduce the vigor of the spring growth and seed production.

Both pests can be controlled effectively with Systox, applied according to the manufacturer's instructions.

Systox and all organic phosphate compounds are poisonous to human beings and animals. Adequate safety precautions must be taken when using these materials.

Thrips have not yet become a pest on blugrass, but they should not be overlooked as a possible threat. Thrips can be controlled with DDT, TEPP, Toxaphene, and other related insecticides.

Stem and yellow-stripe rusts affect seed production at lower elevations.

At low elevations, **stem rust** (*Puccinia graminis poae*) often occurs in late September, but the period of greatest damage has been April and May. Stem rust may be detected by the presence of dark orange to brick-red spore pustules on the leaves, stems, and flower parts. The pustules are elongated and often have ragged edges. The spores are easily dislodged, and are carried by the wind.

Stem rust develops most rapidly when the humidity is high and the days are warm. Approximately 10 days elapse between the infection and the appearance of the pustules. In the spring, rust is first evident on the south side of the plants, and is most severe where rain or irrigation water stands in the furrows.

Yellow stripe rust has been identified as *Puccinia glumarum*. It also occurs at lower elevations, and is perhaps more damaging than stem rust since it is able to develop earlier in the spring under cooler conditions. Infection results in almost complete rusting of the major leaf area of the plants. The spore masses are yellow-orange in color, and are produced in such large numbers as to color the ground under affected plants. Compared with those of stem rust, the pustules are very small. If cool, moist weather persists in the spring, infection may occur on the stems and flower parts. No black spores of this rust have been seen in the Sacramento-San Joaquin Valley.

Very little rust has been observed in the mountain valley areas, and what does occur comes late in the season. Thus far it has been of little consequence.

Relatively high rates of nitrogen fertilization (150 to 200 pounds of nitrogen per acre), plus phosphorus and potash, have a suppressing or retarding effect upon rust development.

Rusts develop rapidly, and can become a threat in a few days.

The rusts are particularly serious because of their rapid development. They can become an economic threat in a matter of days. In order that chemical control can be effective, treatment must start before the rust becomes well established. Frequent treatments are necessary to keep the plants protected over a long period.

Of the materials thus far tested, Phygon X-L has given the best practical and economic control. To be effective, the fungicide must be applied both in the fall and spring, and repeated every seven to 10 days. To insure adequate coverage, sprayers should deliver pressures near 600

pounds p.s.i., or sufficiently high to drive the spray throughout the dense foliage to the base of the plants. Effective rates of application have been 2 to 3 pounds of 50 per cent active material per 100 gallons of water per acre. Systemics and antibiotics have been tested. The systemics, without exception, have drastically reduced seed yields, and the antibiotics in sufficient amounts to be effective have been too expensive.

HOW IS MERION SEED HARVESTED?

Harvest is in late May, early June, in central valleys; as late as July in the mountains.

In the central valley areas, Merion will be ready for harvest about the last of May to the early part of June. In the mountain valleys, maturity may be delayed to the middle of July.

Merion is ready for harvest when the seed heads have lost their green color and a few seeds will shatter from the tops of the heads when they are gently tapped on the palm of the hand.

As with most grasses, the seed at the top of the head matures first, with the ripening proceeding downward to the base. As the seed matures, the heads gradually turn from a green to a light straw color. Heavy attacks of rust often cause such a color change before the seed is mature. Under such conditions, a careful watch of the seeds themselves is necessary to determine maturity.

Uniformity of moisture is essential for uniform ripening throughout the field. This emphasizes carefully controlled application of water during irrigations.

The time required for the whole seed head to mature depends largely on the daily temperatures. Hot, dry weather will shorten the ripening period; cool weather will prolong it.

Merion seed will shatter when mature. Losses from shattering can be serious any time after maturity if the area is subject to strong winds.

Several harvesting methods are commonly used. Broadleaf weeds are a major problem.

Merion bluegrass can be harvested by any of the following methods: binding; direct combining; windrow curing followed by combining from the windrow; or windrow curing followed by pick-up with a Hay-Hog for delivery to a central threshing area. Regardless of the harvesting method used, the presence of large succulent broadleaf weeds creates a major problem either in threshing or in the subsequent cleaning operation.

Growers who, whether by necessity or preference, wish to bind the crop should "tin" their binder. A good tinning

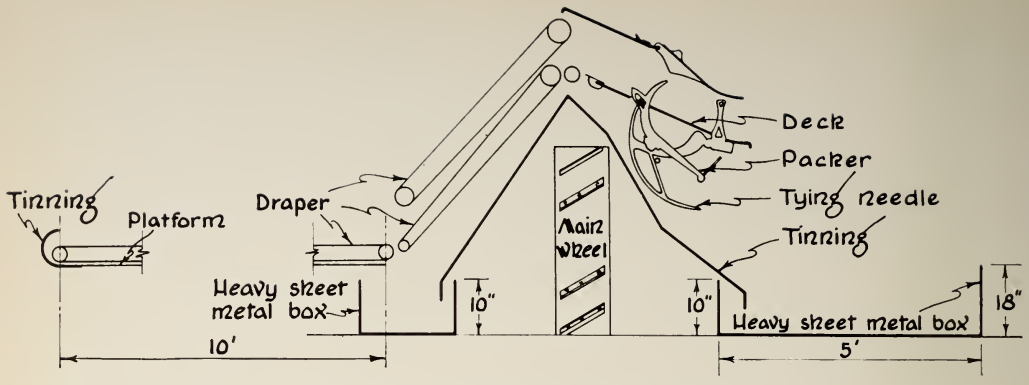


Diagram shows locations of tinning on a binder.

job can save as much as 10 per cent of the crop. The procedure is illustrated in the figure above. The bundle box beneath the edge of the deck can either be mounted in place of the bundle carrier or dragged on the ground. The latter is preferred.

Binding: tinning binder can save up to 10 per cent of a grass seed crop.

The binder reel should be ground driven with a 20 to 30 per cent overdrive. Canvas strips on the reel bats, and lifter-guards positioned to lift the tillers on each side of the row, will reduce losses at the cutter bar.

Bundles from the binder can be handled in either of two ways. Some growers place the bundles in loose shocks to be threshed in the field later; others carefully fork the bundles from the bundle box into trucks or trailers with seed-tight boxes, to be hauled to a central curing area. The curing area is covered with heavy paper or canvas to save all shattered seed. Threshing is then done with a stationary thresher or combine with the reel and cutter bar removed.

Field tests showed rather high seed losses during the actual binding and bundle-handling operation. When binding three 20-inch rows, the grain wheel alone was responsible for losses of from 12 to 107 pounds of seed per acre. Cutter bar losses ranged from 10 to 39 pounds per acre. Cutter bar losses are dependent on height of cut and binder speed.

In addition to high seed losses, the labor and equipment required are high in comparison with other harvesting methods (table 2).

Tests show combining from the windrow has the lowest harvesting loss.

From harvesting tests run in the field, windrow curing followed by combining from the windrow has the lowest over-all harvesting losses. When moderate acreages are harvested, the crop can be left to reach near full matu-

Table 2. Machinery and Labor Force Required to Obtain Merion Seed at the Grain Spout for the First Threshing*

Method of harvest	Acres planted					
	25	50	75	100	200	400
DIRECT COMBINING						
Machinery:						
No. of combines to complete harvest in ten 10-hour work days	1	1	2	2	4	7
Labor force:†						
No. of combine operators	1	1	2	2	4	7
No. of combine foremen	..	..	..	..	1	1
Total labor force	1	1	2	2	5	8
COMBINING FROM THE WINDROW						
Machinery:						
No. of combines to complete harvest in ten 10-hour work days	1	1	1	1	3	5
Labor force:†						
No. of combine operators	1	1	1	1	3	5
No. of combine foremen	..	..	..	..	..	1
Total labor force	1	1	1	1	3	6
BINDING-STATIONARY THRESHING IN CENTRAL CURING AREA						
Machinery:						
No. of binders, PTO driven, to complete binding in ten 10-hour work days	1	1	1	1	2	3
No. of binder tractors, 25 HP class	1	1	1	1	2	3
No. of bundle trailers with seed-tight boxes	1	2	2	2	3	5
No. of bundle tractors, 15–20 HP class	1	2	2	2	3	5
No. of combines used as stationary threshers	1	1	1	1	2	4
Labor force:†						
No. of binder operators	1	1	1	1	2	3
No. of binder tractor drivers	1	1	1	1	2	3
No. in bundle-handling crew	5	8	8	8	13	21
Labor force—binding and bundle-hauling operation	7	10	10	10	17	27
Labor force—stationary threshing (bundle feeders, straw pile men, and combine operators)	5	5	5	5	10	20
SWATHING-STATIONARY THRESHING AT CENTRAL AREA						
Machinery:						
No. of self-propelled swathers to complete swathing in ten 10-hour work days	1	1	1	1	1	2
No. of Hay-Hogs with 15–20 HP tractors	1	1	1	1	1	2
No. of self-unloading seed-tight vans	2	2	2	2	2	4
No. of 15–20 HP tractors for towing vans to central area	1	1	1	1	1	2
No. of combines used as stationary threshers	1	1	1	1	2	4
Labor force:†						
Swather operators	1	1	1	1	1	2
Hay-Hog operators	1	1	1	1	1	2
Tractor van operators	1	1	1	1	1	2
Labor force—stationary threshing	5	5	5	5	10	20

* Minimum requirements based on the estimated harvesting rates, pages 20 and 21.
† Fuel and grease truck man has been omitted.

rity—the point at which tip seeds start to shatter—before windrowing is started. When large acreages are involved, the windrowing will have to be started earlier to prevent excess shatter losses in the field before the operation can be completed.

Windrowing must be done at night or when the plants are damp with dew and least subject to seed shatter. Forward speed of the windrower will usually be 1 to 1.5 m.p.h. to permit the cutter bar to operate satisfactorily. Particular attention must be given to the correct speed, adjustment, and position of the reel (see pp. 19 and 20). When windrowing is carefully done at the proper time and at the above speeds, field losses are shown to average 1.2 per cent of the gross field yield. When windrowers are operated at excessive ground speeds (4 to 5 m.p.h.), losses can be as high as 20 per cent.

Correct adjustment of equipment, proper ground speed reduce seed loss.

Harvesting the windrowed crop with a self-propelled combine can usually begin two days after windrowing, and at the rate of about 0.5 to 0.7 acre per hour. Measured combine losses from a windrowed crop range from 2.2 to 4.5 per cent. Combining very dry material with cylinder peripheral speeds of 7,300 f.p.m. (feet per minute) results in more than 20 per cent of the seed being hulled or broken. This type of damage is increased if the windrow has been subjected to rain. The material in the grain tank must be observed carefully so that cylinder speed can be slowed, if necessary, to reduce damage.

The peripheral speed of the pick-up attachment should be 10 to 15 per cent greater than the combine ground speed. Picking up a windrowed crop grown on raised beds or with deep irrigation furrows has several disadvantages. Much of the windrow will lodge in the furrow, making complete pick-up difficult. Lowering the header platform to increase pick-up causes additional rough handling and increased seed loss.

Direct combining: shatter hazard is increased, and harvested material must be dried.

The use of defoliants or desiccating sprays to cure Merion for direct combining has not been tried. Methods of application would have to be devised to insure that spray material did not contact the seed heads. The thin, papery seed covering could easily absorb the active spray material, thereby affecting germination.

The crop must be more mature for direct combining than for binding. This increases the hazard of excessive seed shatter before harvesting can be completed. Combining before the seed is ripe will produce a considerable amount of light seed and 10 per cent or more will go through the combine without being threshed.

Because a large amount of green plant material and

seed of high moisture content are usually delivered to the grain tank, heating is a problem. It is difficult to empty the grain tank with the grain auger, and immediate drying is necessary. When the green straw has too high a moisture content as a result of excessive late irrigations, heavy dews, or the presence of large, succulent weeds, seed losses will be high because the threshed seed will cling to and not separate from the wet straw.

Direct combining tests have shown seed losses from the rear of the combine to range from 2.3 to 12.8 per cent of the total harvested seed. When the straw row is re-combined after two days' curing, this loss is reduced to 0.5 to 1.5 per cent. Seed losses from the rear of a properly adjusted and operated combine depend primarily on the maturity of the seed crop.

Header losses for the tests averaged 2.5 to 4.5 per cent of the harvested seed.

A low feed rate is necessary to insure high seed recovery.

The rate at which material is fed in direct combining must be kept low if seed recovery is to be high. A 12-foot, self-propelled combine traveling at 0.6 m.p.h. can harvest about 0.5 acre per hour when handling ¾ ton of straw per acre. Depending upon moisture content, the forward speed may need to be as low as 0.4 m.p.h. As the crop matures, it may be possible to increase the speed to as much as 0.8 m.p.h.

A fixed bat reel that is ground powered with 20 to 30 per cent overdrive should be used. At the necessarily low forward speeds, most self-propelled combine reels will be

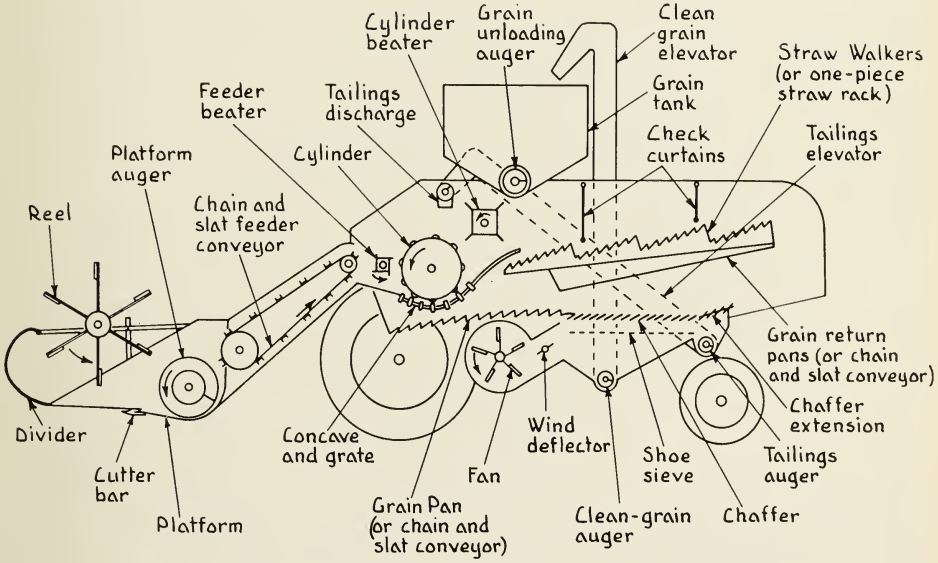


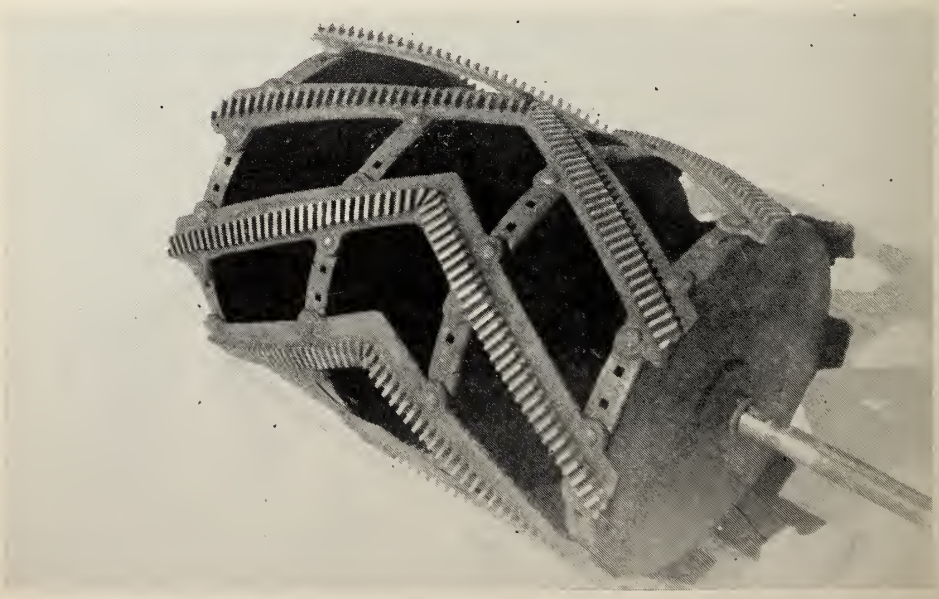
Diagram showing parts of a combine, with terms used in this circular.

overdriven by 100 to 300 per cent. These high speeds cause excessive seed shatter. The reel should be positioned to lay the cut stems on the header platform without pushing the uncut stems forward and away from the cutter bar. The use of canvas or belting on the reel bats and lifter-guards on the cutter bar will help reduce cutter bar losses.

The following are estimated harvesting rates for the various methods:

METHOD	ACRES PER HOUR
Direct combining with 12-ft., self-propelled combine traveling at 0.6 m.p.h. with a field efficiency of 69 per cent. (Includes reasonable allowances for lost time in field and differences between nominal cutter bar width and actual width of cut.)	0.6
Windrowing with 10-ft. windrower traveling at 2 m.p.h. with a field efficiency of 82 per cent.	2.0
Combining from the windrow (10-ft.) with 12-ft., self-propelled combine traveling at 1 m.p.h. with a field efficiency of 74 per cent	0.9
Windrow pick-up with a Hay-Hog traveling at 2¾ m.p.h. with a field efficiency of 90 per cent (9-ft. swath)	2.7
Binding the seed crop with a 10-ft. binder traveling at 1.8 m.p.h. with a field efficiency of 69 per cent	1.5

The V-bar cylinder is most thorough for small seeds.



METHOD	ACRES PER HOUR
Stationary threshing of bundles with 12-ft., self-propelled combine	0.6
Stationary threshing of windrowed straw with 12-ft., self-propelled combine	0.9
Rethreshing of straw with 12-ft. combine used as stationary thresher	1.2

Cylinder speed adjustments are important. Avoid excess speeds.

All types of threshing cylinders perform satisfactorily if they are in good condition and are used properly. However, the V-bar cylinder (p. 20) has been found to be the most thorough for threshing small seeds.

If one of the bar-type cylinders is used, the clearance between the closest cylinder and concave bar should be $\frac{1}{16}$ to $\frac{3}{32}$ inch. If possible, this clearance should be the same at the front and back of the concave. The concave grate openings should be closed for maximum threshing with rasp-bar cylinders. The concave on a spike-tooth cylinder should have a full set of corrugated teeth and be raised to the top position.

Cylinder speed adjustments are made on the basis of peripheral speed—the linear speed of the outside edge of a cylinder bar or the tip of a spike tooth on the cylinder. Revolutions per minute for various peripheral speeds and cylinder diameters are given in table 3.

Cylinder peripheral speeds of 5,900 to 8,500 f.p.m. have been used with no evidence of mechanical damage to the seed, except when the threshed material was very dry or had been rained on. Overthreshing should be avoided. It may be necessary to use cylinder speeds higher than the maximum listed in the "Combine Operator's Manual." *Consult your local machinery dealer before using cylinder speeds in excess of those recommended in the manual.*

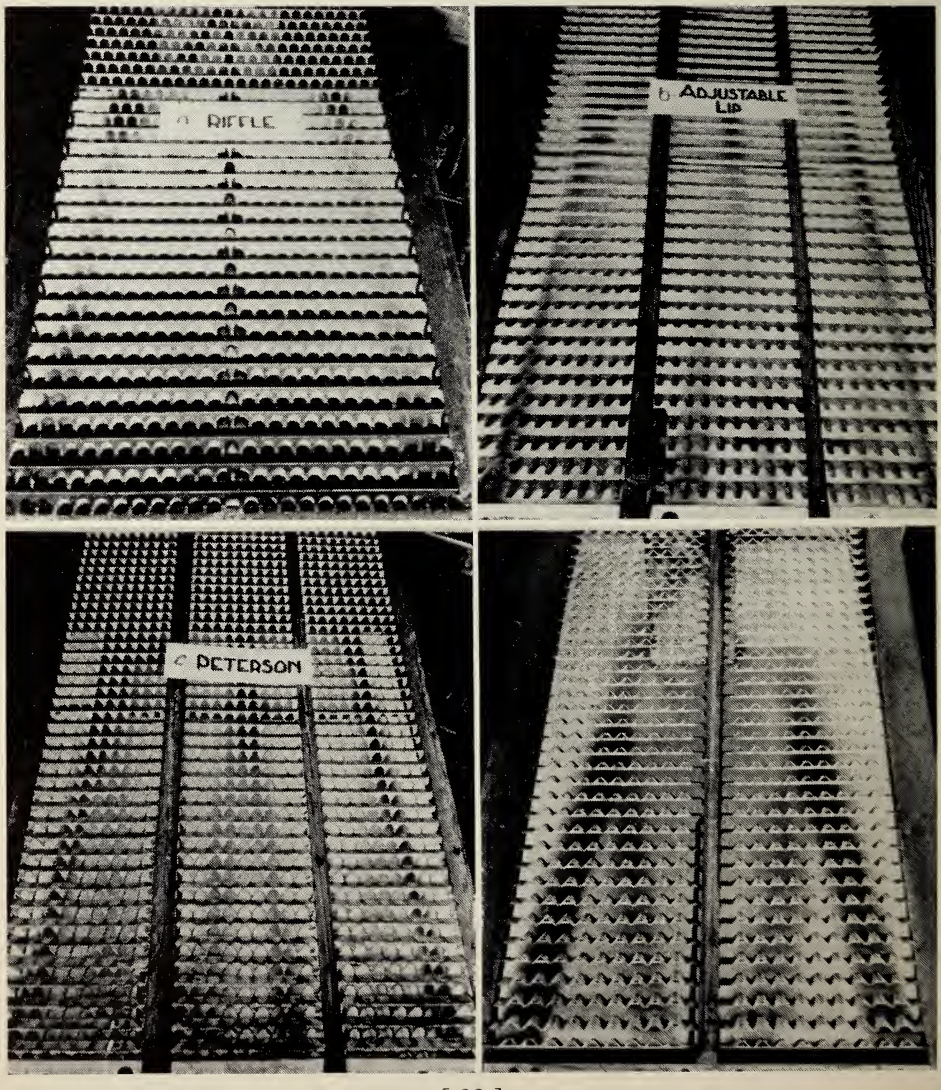
Table 3. Cylinder Speed

Cylinder diameter	R.p.m. (to the nearest 5) to give the following peripheral speeds:					
	6,000 f.p.m.	6,500 f.p.m.	7,000 f.p.m.	7,500 f.p.m.	8,000 f.p.m.	8,500 f.p.m.
inches						
15	1,525	1,655	1,780	1,910	2,035	2,165
17	1,350	1,460	1,575	1,685	1,800	1,910
19	1,205	1,310	1,410	1,510	1,610	1,710
20	1,145	1,240	1,335	1,430	1,525	1,620
22	1,040	1,130	1,220	1,300	1,390	1,475
24	955	1,035	1,115	1,195	1,275	1,355

Straw walkers or racks should be operated at correct speeds: check curtains should be used.

Losses from the straw carrier will consist mostly of unthreshed seed. Walkers and racks should be operated at the speed recommended by the manufacturer. Check curtains should be in the proper position and in good repair. The walker openings, screens, and pans or racks should be periodically checked to see that they are not plugged. Each seed has at its base a fine webbing referred to as the wool or lint. The small size, light weight, and adhering lint present harvesting and cleaning problems not found in many of our common seed crops. Because the seed does

Four types of chaffers. The one shown at lower right is the corrugated chaffer.



Measuring ½-inch opening on adjustable-lip chaffer. Hold tape at right angle to opening axis.

not readily separate from the chaff, the cleaning shoe must be adjusted to deliver a maximum amount of material to the clean-grain elevator.

The adjustable-lip, riffle, Peterson, or corrugated chaffers will give satisfactory performance. The adjustable-lip shoe sieve is generally used, although some seed growers prefer a slotted shoe sieve. A ⅛- by ¾-inch slotted sieve has given satisfactory performance. The adjustable chaffers should be set with an opening of about ½ inch (see illustration). If the adjustable-lip shoe sieve is used, the opening should be ¼ to ⅜ inch.

Shoe should operate as rough scalper, using little or no wind.

The shoe should be adjusted to operate as a rough scalper using very little wind, because the seed is easily blown out of the shoe. Adjustable fan shutters should be closed, and the remaining openings nearly closed with tape or pieces of sheet metal. Wind deflectors should be set to direct what little wind is used to the front part of the shoe. The amount of tailings is controlled by adjusting the openings in the chaffer and shoe sieve and/or varying the feed rate into the combine. A canvas suspended from the rear part of the walker or rack hood will keep tail winds from interfering with the operation of the shoe.

Table 4. Estimated Harvesting Costs for Seed at the Combine Grain Spout*

Method of harvest	Cost per acre for the following acreages:					
	25	50	75	100	200	400
MACHINERY COSTS						
Direct combining:						
Total costs—12-ft., self-propelled combine	$10.15	$ 9.85	$ 9.95	$ 9.85	$ 9.85	$ 9.75
Combining from the windrow:						
Total costs—12-ft., self-propelled combine	$ 6.85	$ 6.70	$ 6.55	$ 6.45	$ 6.60	$ 6.55
Binding-stationary threshing with 12-ft. combine at central curing area:						
Binder (10-ft., PTO), tractor, and twine	$ 7.65	$ 4.50	$ 3.45	$ 2.95	$ 2.95	$ 2.95
Seed-tight bundle-hauling vans and tractors	0.90	3.65	2.90	2.50	1.95	1.65
12-ft., self-propelled combine used as stationary thresher	9.90	9.60	9.40	9.20	9.20	9.20
Total machinery costs	$18.45	$17.75	$15.75	$14.65	$14.10	$13.40
Swathing, pick-up with Hay-Hog—stationary threshing with 12-ft. combine at central area:						
Custom swathing with 10-ft., self-propelled swather (includes oper.)	$ 1.90	$ 1.90	$ 1.90	$ 1.90	$ 1.90	$ 1.90
Custom swath pick-up with Hay-Hog (includes 2 tractors, 2 vans, 2 oper.)	3.95	3.95	3.95	3.95	3.95	3.95
12-ft., self-propelled combine used as stationary thresher	6.30	6.15	6.00	5.90	5.90	5.90
Total machinery costs	$12.15	$12.00	$11.85	$11.75	$11.75	$11.75
Rethreshing straw at central area:						
12-ft., self-propelled combine	$ 4.90	$ 4.70	$ 4.60	$ 4.50	$ 4.50	$ 4.50

LABOR COSTS†						
Direct combining:						
Total labor (operators and foreman)	$ 2.00	$ 2.00	$ 2.00	$ 2.00	$ 2.83	$ 2.48
Combining from the windrow:						
Total labor (operators and foreman)	$ 1.33	$ 1.33	$ 1.33	$ 1.33	$ 1.33	$ 1.78
Binding-stationary threshing with 12-ft. combine at central curing area:						
Binding-bundle handling	$ 5.00	$ 6.67	$ 6.67	$ 6.67	$ 5.67	$ 6.00
Threshing with 12-ft. combine	8.67	8.67	8.67	8.67	8.67	8.67
Total labor	$13.67	$15.34	$15.34	$15.34	$14.34	$14.67
Swathing, pick-up with Hay-Hog, stationary threshing with 12-ft. combine in central area:						
Threshing with 12-ft. combine	$ 5.78	$ 5.78	$ 5.78	$ 5.78	$ 5.78	$ 5.78
Rethreshing straw at central area:						
Total labor	$ 4.33	$ 4.33	$ 4.33	$ 4.33	$ 4.33	$ 4.33
TOTAL HARVESTING COSTS						
Direct combining	$12.15	$11.85	$11.95	$11.85	$12.68	$12.23
Swathing-combining	$10.08	$ 9.93	$ 9.78	$ 9.68	$ 9.83	$10.23
Binding-stationary threshing‡	$32.12	$33.09	$31.09	$29.99	$28.44	$28.07
Swathing-stationary threshing‡ (first threshing only)	$17.93	$17.78	$17.63	$17.52	$17.53	$17.53
Rethreshing straw at central area‡	$ 9.23	$ 9.03	$ 8.93	$ 8.83	$ 8.83	$ 8.83

* Based on the harvesting rates on pages 20 and 21 and the machinery and labor requirements of table 3.
† Combine operators, $1.20/hr.; combine foremen, $2.00/hr.; all other labor, $1/hr.
‡ Costs for preparing curing area, i.e., paper, canvas, etc., are not included.

Seed loss over the shoe in direct combining tests with the above shoe adjustments averaged 0.5 per cent of the harvested seed. About one half of the loss was unthreshed seed. The adjustable-lip chaffer and shoe screen were used in these tests.

Combine adjustments recommended for direct combining should be followed when combining from the windrow or when the combine is used as a stationary thresher.

If circumstances dictate threshing in a central area, a Hay-Hog with a ground-driven lifter beater can be utilized to place the windrow-cured crop in covered vans for transport. When the Hay-Hog was used in a flat-planted field, pick-up loss ranged from ⅓ to 5 pounds per acre.

Tables 3 and 4 and the harvesting rates on page 20 are presented as aids to the grower in making his decision as to the harvesting method to use. The harvesting rates may vary, depending on local harvesting conditions, but the harvesting periods should not be extended if shatter losses are to be held at a reasonable level. These two factors and the acreage to be harvested will determine the amount of machinery required for any harvesting method. The labor input listed for each harvesting method in table 2 is near the minimum amount required to complete the harvesting in the time specified in the table. Machinery costs of table 4 will vary, depending on the total hours operated each year and the hours required to harvest the Merion seed crop. Combines were assumed to operate 200 hours per year in crops other than Merion. The fixed combine costs were proportionately charged to this crop. The total cost of the binder operation was charged to the Merion crop with 75 cents per acre allowed for twine.

HOW IS MERION SEED PROCESSED AND CLEANED?

Most seed growers do not have the necessary equipment for processing and cleaning their own seed. A brief description of the method and problems encountered in handling Merion is therefore included as a help to both the grower and seed processor.

Harvested material is 50 to 60 per cent inert matter; rethreshing to recover seed is necessary.

The harvested material from the thresher or combine contains a high percentage of inert matter, usually 50 to 60 per cent by weight. This is made up of pieces of leaves, stems, glumes, and the like. Among this material are portions of unthreshed heads, spikelets, and some free seed. The processor first puts the seed lot over a scalper which separates the greater portion of this bulky material. In

most cases it will pay to rethresh these scalpings. Unless there is a very large volume it may be done with a modified hammer mill. The salvaged seed is then returned to the seed lot for processing and cleaning.

Before cleaning, seed is processed to remove lint. Seed must not be damaged in this process.

Before cleaning, the seed should be processed to thresh all unthreshed seed and remove the lint or wool from the seed. Large mats or balls of seed will cling together and be lost in the screenings or removed by air if this is not done. The processing is usually done with a modified hammer mill or a barley bearder. The speed of either machine must be controlled to prevent damaging the seed by impact or heating and thereby reducing germination. The actual cleaning process varies little from normal seed cleaning operations. Smaller screen sizes and more critical air adjustments are necessary.

Finished seed may weigh 21–30 lbs. per bushel.

Most of the commercial bluegrass seed on the market is cleaned so that the finished product weighs about 21 pounds per bushel. Superior grades up to 30 pounds per bushel are sometimes offered.

After this circular was submitted for publication, the Federal Seed Act established the official name of this grass as "Merion Kentucky Bluegrass."

In order that the information in our publications may be more intelligible it is sometimes necessary to use trade names of products or equipment rather than complicated descriptive or chemical identifications. In so doing it is unavoidable in some cases that similar products which are on the market under other trade names may not be cited. No endorsement of named products is intended, nor is criticism implied of similar products which are not mentioned.

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